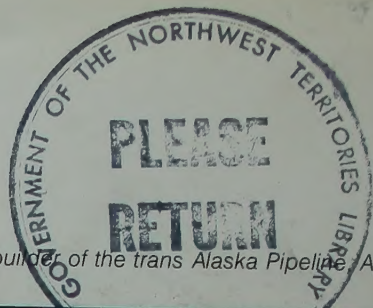




Three views: A rock saw cuts a ditch in frozen soil

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More than 17,000 machines, valued at nearly \$500 million dollars, have been marshalled for construction of the 800-mile trans Alaska pipeline.

About 14,500 pieces of heavy equipment, worth \$470 million, are involved in construction of the pipeline itself. Another 2,950 pieces of equipment worth \$30 million are being used in construction of the pump stations and terminal.

A few of the machines were specifically designed for the huge project. Some were developed because half of the pipeline is being built above ground rather than being buried in the conventional manner. Other machinery developments were related to the climate and

the permafrost which underlies much of the route.

Some special machines were planned in anticipation that available machinery could not perform the work to the required schedules. And others are products of innovative equipment manufacturers and contractors.

But most of the machinery is conventional equipment modified to perform this particular pipeline job.

The installation of vertical members to support above-ground sections required drilling 78,000 holes 24 inches in diameter and up to 50 feet deep. Alyeska asked several manufacturers to develop special

drills for the task and the 38 machines purchased installed 42,000 of the supports last season, more than half of the required total.

The drills fall into three classes: rotating augers, percussion drills and chisel drills.

The rotating auger machines, big brothers to drills used to excavate caissons for building foundations, are fitted with teeth of hard, tough alloys for digging through rock and permafrost. The special teeth on these augers may wear out after drilling only a few feet of hole. And the entire auger may require changing every two or three holes under severe conditions.

The percussion drills are patterned after the rock drills used for drilling blasting holes in roadway cuts and quarries.

Their 24-inch diameter bits are studded with hard tungsten carbide "buttons" which pulverize rock or frozen material as an air hammer drives the bit down the hole at 675 blows per minute.

Air from a large compressor, fed to the top of the 20-inch drill stem, passes down the hollow center of the stem and out through holes in the end of the bit. The air forces cuttings up to the surface through a space around the bit.

The third or chisel-type drills are commonly used in soft or wet ground. In one configuration, these drills work inside the 18-inch vertical support member (VSM). The drill's chisel-like bits chew into the bottom of the hole, breaking the earth into chips. Air, forced down around the outside

MACHINES AND

By Ralph E. Monson

Earth moving machine constructs pipeline work pad



Heaters warm pipe before it is wrapped by machine

of the bit, returns up through the center of the drill stem. This reverse circulation system forces cuttings back up through the stem and discharges them. The VSM is driven down as the hole deepens.

Another versatile machine is employed to place the supports. It positions and plumbs them accurately and then holds them securely while a sand-water slurry is placed around them. Mounted on a heavy truck, this rig consists of a hydraulic crane, a positioning arm adapted from a hydraulic backhoe and a cab at the rear of the truck from which the operator can control all functions.

The machine's crane lowers the support into the hole. The positioning arm grasps it with its hydraulically operated claws, adapted from logging grapples. The arm then moves the VSM into position, holding it plumb and securely in place.

The crane is used now to set a big vibrator into the top of the support. As a mixer discharges the slurry into the hole around the VSM, the vibration of the pipe consolidates the slurry. The slurry freezes within 24 hours, bonding the support into the permafrost.

Conventional transit concrete mixers deliver the slurry. To keep the mix warm, some have foam insulation sprayed on the drum. Others have an insulated enclosure around the drum.

In the buried mode of pipeline construction, much of the pipe

trench is blasted through rock or permafrost. This is a method commonly used on most pipelines, and it is used here with the same equipment as elsewhere. Pairs of air drills suspended from sideboom tractors drill rows of holes.

Workmen load the holes with dynamite and detonate them to break up the rock or permafrost.

Backhoes with buckets ranging from 2 to 4 cubic yards then excavate most of the trench, which is 7 feet wide at the bottom and from 8 to more than 25 feet deep. Contractors are using standard hydraulic backhoes, but beef up critical parts to resist extreme cold and tough digging.

A machine originally designed and built to assist in excavation of the large ditch is proving highly successful at another job. Called

the Roc Saw, this gigantic chain saw with a blade 14 feet long and driven at 800 feet per minute digs the ditch for the eight and ten-inch natural gas pipeline being built from Prudhoe Bay to four North Slope pump stations.

The blade of this huge saw is mounted on a large tractor, modified specially for this use. Its hardened steel teeth chip away rock or permafrost, cutting a neat trench 18 inches wide and up to six feet deep at a rate of five to eight feet per minute. Conveyors carry the soil "chips" to spoil banks on either side. The whole machine weighs 130,000 pounds. The chain itself weighs 5,000 pounds with 600 pounds of that being the

D EQUIPMENT

Illustrations by Jim Hays

Rig bores hole for vertical support members



Welders work inside winter shelter on vertical support member



weight of the teeth alone.

While pipeline trenches are being dug and vertical supports are being installed, pipe crews assemble the pipe on the work pad and weld it into long continuous strings. Except for the heaters to warm the pipe, machines used here are essentially the same as on other pipelines.

Before welding begins, propane torches heat the pipe to 200 degrees Fahrenheit. An interior heater, consisting of torches arranged like the spokes of a wheel, heats the pipe so welders can make the first of the passes required to complete each joint. For succeeding passes, external propane heaters bring the pipe back up to the required temperature.

Separate welder teams make each of the welds required to complete a joint. Thus, work is in progress at six or seven joints at one time. Diesel powered welding generators, carried on tractors or towed sleds, provide

the welding current.

Special metal-framed, canvas tents with electric heaters and exhaust fans, built in camp shops, protect the welders from inclement weather. Cutouts in the ends of the tents fit over the pipes, and doors in both sides admit the workmen. Small cranes or sideboom tractors leapfrog the tents from joint to joint.

Each joint is X-rayed to check for possible flaws. Pipeline technicians worked with a manufacturer of film processing equipment to develop a portable unit which processes film ready for viewing, within three minutes after an X-ray exposure is made. Buried pipe is given a protective coating of specially formulated tape with a self-melt adhesive before it is buried.

Machines for applying the tape were built specially for the Alaska pipeline job. The machines propel themselves along the pipe as sideboom tractors "cradle" the pipe.

The tape is applied directly to the pipe without a primer after external propane burners heat the pipe to 200 degrees Fahrenheit. When the pipe is very

cold, external propane heaters may not be able to heat it quickly enough. One contractor, therefore, developed an auxiliary heater consisting of a section of four-foot pipe which can be heated red hot by the flame of a large oil burner directed into one end. A huge fan draws hot air from the hot pipe and blows it into a section of line being readied for taping. Even though the section might be three miles long, and the air temperature may be minus 20 degrees Fahrenheit, the heater can raise the temperature of the pipe to 30 degrees Fahrenheit or higher.

Banks of the specially designed external propane heaters can then be used to bring the pipe on up to 200 degrees Fahrenheit immediately ahead of the taping machine.

After the long strings of pipe have been welded and taped, squads of sideboom tractors pick the pipe from its timber cribbing and ease it into the trench. Anticipating problems in backfilling around the pipe, Alyeska purchased special machines designed to heat and dry backfill sand and place it

under and around the pipe. These giants of the pipeline travelled on two sets of crawler tracks and measured 78 feet long and weighed 210 tons.

As the backfilling sequence was planned, the pipe was to be lowered into the trench onto a series of air bags which would hold it above the bottom of the trench. The backfilling machines then were to place dry sand under the pipe between bags. After the bags were deflated and removed, the remainder of the backfill would have been put in place.

Several of the big machines were delivered and used. But although they worked, they proved cumbersome. Alyeska then modified specifications for the backfill, and pipeliners improvised equipment to place it. Under the revised specifications the air bags were eliminated. Bedding is placed in the trench and graded by a small tractor-dozzer. The pipe is laid on the bedding.

Ralph E. Monson, a registered professional engineer from California, has been writing about construction and the construction industry for more than 23 years, covering most of the large projects throughout the world during that time.

Jim Hays is a West Coast illustrator who lives on a farm near Seattle with his wife and three children. His work has covered Alaska and Pacific Northwest subjects.

Manipulator grasps pipe insulation panel as crane swings it into place over pipe at left



At one site, a machine used for trimming highway grades picks up backfill material from a windrow on the pad and places it in the trench with a belt conveyor. At another site, a contractor modified a wheel-type trenching machine to place backfill by raising the machine up on stilt-like legs so the digging wheel operates at ground level.

Insulation is one of the unique features of the above-ground pipe. Prefabricated panels of four-inch glass fiber insulation, bonded to sheet metal and stacked in crates, are placed along the pipeline. Each panel, more than 23 feet long and 12½ feet wide, is folded in the middle.

An unfold machine and a manipulator handle the insulation. Their Rube Goldberg appearance belies the simplicity and efficiency with which they operate. The unfolder unfolds the insulation panel and spreads it out flat with the metal sheath up. The manipulator, an articulated pad with 24 vacuum cups suspended from it, is handled by

a small hydraulic crane. Extended flat, the manipulator is lowered over the insulation panel. The vacuum cups grip the panel and the crane picks it up. The crane swings the panel over the pipe where the manipulator wraps the insulation around the pipe. Workmen install a row of bolts in the overlapping edges of the sheet metal sheath, and the manipulator moves on to the next panel.

The entire pipeline receives a hydrostatic test. Sections of the line are filled with water at pressures exceeding that under which they will operate. The pressure is maintained for 24 hours. Getting the large volume of water into and out of the pipe without contaminating the streams from which it comes and keeping the water from freezing in the pipe are among the obvious problems.

One contractor proposes to circulate heated water through the pipe until an area around it is thawed. Then the pipe would be tested for 24 hours and the water removed before it freezes. This contractor has two oil-burning heaters. Each will provide a 20-

degree rise in 4,000 gallons of water per minute.

Large pumps and in some cases the entire flow of a stream will be required to fill the pipe. After testing, specially designed air compressors producing 2,000 cubic feet of air per minute at 800 pounds per square inch pressure will drive pigs (moving plugs) through the pipe to force the water out. Water will be returned to streams under the closely controlled conditions of an Environmental Protection Agency permit.

Building the pipeline through spectacular Keystone Canyon just north of Valdez presents one of the most challenging problems of the project. The line there is to be laid out on a steep mountainside where the construction scar will be least conspicuous.

A major problem was access to the work. The rock excavation could never be completed on time by working only from the ends. So a giant helicopter was used to airlift construction



Rock drill bores holes for blasting in rock along pipeline route

Transporter carries 240-ton condensers on Valdez Terminal construction site

equipment to four sites on a high bench above the canyon. Making more than 30 drops in only four hours, a Sikorsky Skycrane delivered ten dozers, eight airtrack drills, nine compressors and other equipment.

The largest tractors and drills were dismantled and flown to the sites in pieces. The largest single lift was a complete Caterpillar D4 tractor weighing 19,800 pounds, approaching the 20,000-pound capacity of the helicopter.

While most construction operations at the Valdez terminal utilize conventional equipment and methods, there are some unusual machines. One is a gigantic transporter on crawler tracks which moves heavy prefabricated elements from barges to their destinations. The transporter consists of two crawlers, like those under heavy crawler cranes, joined by a steel frame. They can carry loads up to 300 tons.

Each crawler, 19 feet wide and 22 feet long, is powered by a 320-



Skycrane helicopter lifts tractor above Keystone Canyon



horsepower diesel engine. Individual tracks are four feet wide. The transporter has already moved a number of condensers weighing 240 tons each, three 130-ton boilers and two 170-ton sections of stack from barges to the Valdez powerhouse.

Two large mobile cranes, used to set these heavy units, have 100-foot masts and auxiliary trailing counterweight tanks filled with water to give them the required lifting capacity.

At the waterfront, the contractor building the tanker berths uses sophisticated drilling equipment to set piling into the rock bottom of the harbor. One of the drills mounts on top of a pile and drills down through it. It drills 24 or 36-inch holes into the rock and then reams them to 54 inches to receive the big pipe piles which anchor the berths to the rock.

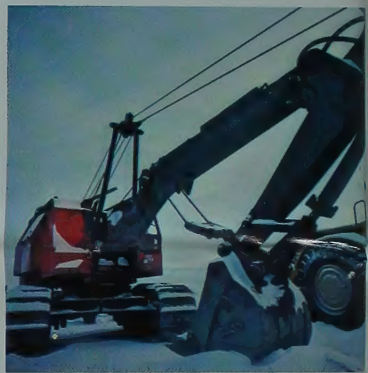
Machine wraps protective tape around pipe to be buried

This is one of a continuing series of articles about aspects of the pipeline's construction.

COLD

By Vicky Sterling

Photographs by
Edward Kohnstamm



It's cold out there. Not just chilly. And not just sometimes. But downright cold. Most of the year. Along most of the trans Alaska pipeline route. And despite all of the innovations by all of the engineers.

Therefore, those involved in pipeline construction must deal with the cold. They must understand what it can do, respect it for its power and sometimes even make concessions to it.

"Thirty below is the magic number," says Brent Stonebraker, an Alyeska senior construction engineer at Galbraith Lake Camp in the northernmost section of construction. "Men can work at minus 50 degrees Fahrenheit, but not machines."

Stonebraker's impressions are echoed by H. L. "Red" Tinkler, Arctic Constructors site superintendent at Dietrich Camp located 95 miles north of the Arctic Circle, and about 70 miles south of Galbraith Lake. "Fatigue on metal is terrible at minus 30 degrees and lower."

"We ask for a construction shutdown at minus 30," says John Coats, Bechtel field



equipment superintendent based in Fairbanks. "Below that you notice a big difference," confirms Dick Colf, Arctic Constructors superintendent for installation of vertical support members at Dietrich.

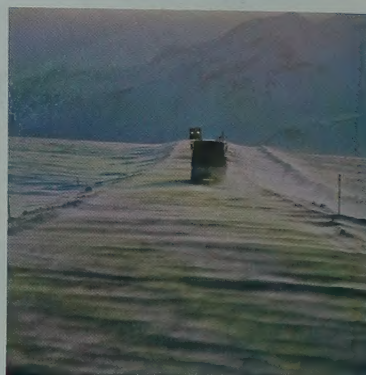
Although many in the field will agree that 30 below is a magic number in terms of winter operation, preparation for sub-zero temperatures begins long before the temperature slips below zero for its indefinite stay. Light vehicles receive a special Arctic oil for engine, wheel bearings and rear end lubrication. A circulating tank heater is plugged into an electrical current to prevent freeze-up of the vehicle's cooling system. A battery heater is

added. Air deflection flaps often are attached to the front of the grill to control the amount of cold air which hits the engine, and Arctic fan belts made of a material designed to withstand extreme cold replace the standard belts.

Practices vary, but engines on most light vehicles along the project are kept idling through much of the winter. If a vehicle is not running, a tank heater is plugged in to prevent freezing. Although many vehicles are able to sit with their engines stopped for several hours and still remain functional, the preventive measures save time, money and wear and tear on the vehicle in the long run.

Hheavy pieces of equipment also are winterized. If a battery box is not standard on a piece of machinery, one is installed. Standard lubricants are replaced with a special Arctic lubricant. An Arctic cab which is fully insulated and equipped with a heater is added. As with the light vehicles, most pieces of heavy equipment scheduled for use during the long winter are left running.

Vicky Sterling, a former Alaska newspaper writer and editor, is editor of Alyeska's construction camp newspaper, *The Campfollower*.



mechanics and many others often must work outdoors, and even when the thermometer indicates a balmy 20 below the wind can and does produce a chill factor equivalent to a minus 85 degrees. An air temperature of minus 30 with a 15 mile per hour wind produces a chill factor of minus 65 degrees, and chill factors equivalent to 100 below have been recorded more than once. Proper attire and extreme caution when handling liquids, especially fuels, is vital at such temperatures.

"Wool is the mainstay of working in cold weather," says Lawrence O'Neill, an expeditor from Fairbanks employed at Prospect Creek Camp located 80 miles north of the Yukon River. Jim Klapps, a laborer who has worked in cold weather for many years and has been at Coldfoot Camp about 40 miles north of Prospect Creek for two years, elaborates: "People should wear layers of loose clothing and bigger shoes than usual so they don't bind up. It's a good idea to have extra gloves on hand, too."

"The wintertime knocks the sap out of you," he concludes with a smile. "But I'm used to it. I like working in the winter."

"Working outdoors in the winter doesn't bother me at all," says Jerry Strong, a fueller from Anchorage who works at Coldfoot. "Naturally it takes more energy and you have to be more cautious working with fuel. If I had a different place where I could make as much money, I'd go there, but the cold doesn't affect me that much."

Stephen LaCroix, a laborer at Prospect Creek whose home is Syracuse, N.Y., says, "I worked outside all day at minus 50 degrees and was ten times more

tired than usual." But LaCroix points out that the strain can be combatted. "Sleep and food make all the difference."

The extra gear can be clumsy, and probably doesn't fit anyone's definition of attractive, but combined with plenty of sleep and food, it works. And exercising equipment may take extra time—but it works.

And since the cold can't be stopped, it must be dealt with.



The equipment operator must exercise his machine slowly. The transmission is exercised by slow, short back and forth movement. Hydraulic systems similarly are extended and contracted a few inches at a time until the operator can work them to full travel.

Just as precautions must be taken to protect equipment in the Arctic environment, man must protect himself. Proper Arctic gear includes a down-filled parka, down pants, down mittens, Arctic boots and face mask. A duffel bag to carry any articles not being worn is not only important but required. Camp maintenance personnel,

When heavy equipment which has been shut down is brought back into cold-weather operation, the start-up procedure is painstaking. The first step is to check the oil. If it is too cold to drip, the crankcase must be warmed with a space heater. Frequently a canvas tent or parachute is placed over the machine to trap the warmth produced by the heater. The same tents or plywood structures are also employed if a machine requires mechanical work and cannot be taken to a shop.

The warm-up process may take from four hours to two days, depending upon the severity of the weather. Even after the machine is warm enough so oil flows to moving parts and the engine can be started, the battle is but half over.

Cold body metal and hydraulic systems must be brought into operation slowly. When temperatures drop lower than minus 35 to minus 45 degrees, steel and rubber assume new characteristics, and can shatter like crystal.

"I've seen a 1½-inch thick steel bar break like glass," says Earl "Skip" Franck, a master mechanic who has been in every camp north of the Yukon River.

The forces that formed Alaska

By Irene Kiefer

Scientists have long found it difficult to explain the geological history of Alaska. But a new far-reaching concept may help to unravel some of the mysteries that surround this most complex geological region.

Called plate tectonics, the new concept in just the last decade has come to dominate the earth sciences. Geologists have generally been successful at explaining what has happened to the earth, but considerably less successful at explaining how it happened. Now accepted by all but a handful of geologists, plate tectonics is forcing a re-examination of much of what is known of the earth's past and present in what is one of the swiftest and most sweeping

such questions as:

- Why earthquakes and volcanoes are common in Alaska and other regions that rim the Pacific Ocean.

- Why mineral resources are distributed in such an apparently random manner — for example, why oil, formed from the remains of luxurious growth generally associated with warm climates, is found in the Arctic.

- How mountains are formed.

Studies of Alaska's tectonic history started about 1930. Originally, they focused on structural evidence that could be observed on the surface — major faults and mountain ranges, for example. More recent studies have involved seismic activity and detailed scientific analysis

plate, which includes the Seward Peninsula and southwestern Alaska, the Kuskokwim mountains and Yukon-Koyukuk Basin were already in place. Finally, there was the Pacific plate, which bears the Aleutians south central Alaska, and the Panhandle area of southeastern Alaska as well as the portion of North America west of the San Andreas fault.

The Pacific plate, though contributing only a small part of Alaska's landmass, tells an intriguing geological story. Similarities between rock formations in the Alaska Panhandle and the eastern Klamath Mountains of northern



1. According to the theory of plate tectonics, the earth's seemingly rigid outer shell is actually a slowly moving mosaic of continental "rafts" or "plates" moving constantly and slowly.

2. Starting about 75 million years ago, three of these continental plates — the North American, Eurasian, and Pacific — began to come together in Alaska, forming many of the geological features found there today.

3. In some places, one great plate has forced its way beneath the borders of another, distorting the earth's surface causing earthquake and volcanic activity in the converging regions.

revolutions ever to have occurred in the sciences.

The new theory is based on an old idea that the world's continents were formed when parts of what was once a single landmass drifted away from one another.

According to the plate theory, the earth's seemingly rigid outer shell is actually a crazy-quilt mosaic made up of a dozen or so huge rafts, or "plates," that float on the hot, soft rock below. In some places, the plates, which measure 30 to 60 miles thick, grind and override each other like ice floes. In other places, they pull apart or slide past one another. These movements, especially in the last 200 million years of the earth's 4.5-billion-year history, seem to answer

of the origin, age, history, and composition of specific rock formations.

From these studies, unified by the concept of plate tectonics, has emerged a still highly conjectural and simplified picture of how modern Alaska may have come into being.

Starting about 75 million years ago, some scientists believe, three continental plates — the North American, Eurasian, and Pacific — each with pre-existing features, began to come together. On the North American plate, which in Alaska extends from the Arctic Ocean to the Yukon Flats, the North Slope oil field and the Brooks Range were already in place. On the Eurasian

California suggest that the Panhandle may be a fragment of the North American plate that broke loose about 100 million years ago and moved to Alaska as part of the Pacific plate.

The collision of the three plates also added several new features to the Alaskan scene. For example, the Alaska Range was formed when the northeastern edge of the Pacific plate met a segment of the Eurasian plate. And the metal deposits in south central Alaska — as well as valuable deposits in many other regions of the world — may have been formed by concentration processes that took place when the Pacific plate plunged under the margin of the Eurasian plate.

The concept of plate tectonics grew from the idea of continental

Irene Kiefer is a free-lance science writer of Bethesda, Maryland. Her work has appeared in *Smithsonian Magazine*, *Mosaic* (the official magazine of the National Science Foundation), and publications of the U.S. Environmental Protection Agency.

drift. The first roughly accurate maps of the world were drawn following the voyages of discovery made in the late 16th century. They showed that the coastlines of the continents, from the Arctic to the southern tips of Africa and South America, paralleled each other in a sweeping S-curve. A German meteorologist, Alfred Wegener, first developed the idea in some detail. Early in the 20th century, he proposed that until about 200 million years ago, the continents were all one huge landmass, which he named Pangaea ("all earth"). This supercontinent occupied one half of the globe, with a vast ocean covering the other half. Then, according to Wegener's theory, Pangaea

Wegener's theory until scientific techniques developed during and after World War II breathed new life into the old idea. Preparing for undersea warfare, the U.S. in the late 1950s undertook a huge program to map the world's ocean floors. New echo sounding devices used in the program revealed that a 40,000-mile chain of submarine mountains wound round the entire globe like the seam of a baseball. The most startling of the ridges is almost centered in the Atlantic, where it parallels the continental shelves of North and South America on the west and Europe and Africa on the east.

At about the same time, new supersensitive seismometers, set

continents do not travel *through* the upper part of the crust, as Wegener had thought, but *with* it, moving at rates varying from one-half to five inches per year.

Depending on the speed and angle at which plates meet, several results are possible:

- If one plate rides over the other, the lower plate is pushed down into the earth's hot interior. The result is volcanoes and deep earthquakes such as those of the Aleutian trench.
- If plates merely grind together, shallow earthquakes such as those at the San Andreas fault, occur.
- If the plate edges are forced up by the pressure, mountains such as the Alaska and Chugach Ranges are formed.

the basis of the edges of their continental shelves. What is now Anchorage was then about 2,000 miles to the southeast of its present location. When Pangaea began to break up, the northern landmass rotated clockwise. Eventually, the Atlantic was formed, breaking the northern landmass into two plates — the North American, which drifted northwesterly to its present location, and the Eurasian, which drifted to the northeast. The Pacific plate with the modern Pacific Ocean formed one of the largest major plates on the earth's surface. Its edges are being forced beneath the edges of the adjacent continents, creating the "Pacific Ring of Fire," a belt marked by



4. Molten lava oozes from huge cracks in the sea floor in some parts of the world to force sections of the crustal plates outward, separating some continents and moving others together.

5. Geologists theorize that about 200 million years ago all of the continents on earth today were joined in one huge landmass called Pangaea which has since been split apart by the tectonic forces.

began to break into fragments that, being composed of light rocks, floated on the heavier rocks of the ocean floor. Like icebergs, the continents drifted through the oceans, driven by forces related to the earth's rotation system.

Wegener based his proposal not only on the jigsaw puzzle fit of the continents, but also on a large amount of data he had collected showing past similarities between the climate, rocks, plants, and animals in different continents. The geological establishment found Wegener's evidence wanting, and, his ideas scorned, he died on an expedition to Greenland in 1930.

Except for a few diehard "drifters," geologists shunned

up to detect underground atomic tests, revealed that about 90 per cent of the world's earthquakes occur in a few narrow zones — known fault lines, the newly identified midocean ridges, and a series of deep-sea trenches, such as one off the Aleutians, that circle much of the Pacific Ocean.

Out of these developments came (in 1960) the theory of "sea-floor spreading," which postulates that at the crest of the midocean ridges hot lava from the earth's interior oozes up onto the crust. As it hardens, it cools and welds to the plates on both sides of the rift, forcing them outward, as if they were on a conveyor belt, in both directions on the ocean floor. Thus, the

• If the edges hold, other parts of the plate wrinkle, just as a carpet does, forming mountains such as the Brooks Range.

The next few years brought additional support to the idea of sea-floor spreading. Studies of the magnetic properties and ages of rocks, as well as distribution of fossils, have convinced the majority of geologists — but not all — of the general validity of sea-floor spreading and its role in plate tectonics.

By reconstructing the movements of the plates, scientists believe that until about 200 million years ago, Pangaea was intact, surrounded by the ancestral Pacific Ocean. Pangaea's shape is outlined by fitting the continents together on

earthquakes and volcanoes.

All of the plates still continue to drift, so that in the future, the earth's crust will have changed into forms that can only be guessed at today.

Few ideas in science merit the description of being revolutionary. But the concept of plate tectonics does. By postulating a world that is active and dynamic, not passive and static, the theory of plate tectonics joins a handful of ideas — among them biologic evolution and the recognition that the sun, not the earth, is the center of our planetary system — that have profoundly changed man's understanding of the natural world in which he lives.

Women find challenges on pipeline

By Betzi Woodman

Betzi Woodman has covered pipeline activities in Alaska since the project began there. A former reporter on Alaska newspapers, she has been an Alaska correspondent for Reuters, Ltd., since 1963.

"Two hundred females to 2,500 males is really no picnic. And it strikes home the first time a woman goes to eat. She walks down a center aisle, followed by 500 pairs of male eyes that all seem to reflect the same thought. This starts at 6 a.m. and continues through all ten hours of the day."

"You have to prove yourself beyond what any man would have to on the job. Once you pass that bath of fire, you're generally accepted."

"The pressures are heavy, but you can establish how you want to be treated. You have to let it be



Vee Ola Corso

known right off what you are and how you will respond to the guff and joshing . . . and this does not depend on just words."

"I have a right to work here, too. I don't get a discount from the dentist for filling my teeth because I'm a female."

"The people I meet are fabulous. I never mixed with blue collar workers before and I'm beginning to see what makes this country tick."

These are statements of women working on the trans Alaska pipeline. When it first got underway, there were three major taboos in the work camps — guns, liquor and women. And, of these, women were considered least likely to

become part of the scene.

Yet when pipeline construction employment hit a peak of nearly 18,000 workers last September, more than 1,900 were women. And of these, more than 55 per cent were in non-traditional occupations at remote camps — laborers, ironworkers, teamsters, operating engineers, surveyors.

Employing women on the pipeline is part of an affirmative action program for hiring minorities which has its legal footings in the pipeline Right of Way Agreement and an act passed by Congress in 1964. Although structured similarly to program enforcement for Equal Employment Opportunity under the U.S. Labor Department, goals for the pipeline are higher and enforcement is by the Department of Interior.

In spite of traditional objections from many male workers, particularly older men, the level of acceptability for women has "risen by leaps and bounds," according to Glenn H. Lundell, manager of Alaska Manpower Resources for Alyeska Pipeline Service Company. Lundell admits that the women, perhaps more than other minorities, have had to prove themselves above and beyond what a man might have to.

"But once they're in, they're in. And decorum in camps has improved," he says. "I am relieved at how it's turning out. It

is destroying the myth that women can't pull their loads in harsh situations."

Who are these women who brave the resentments, long hours, harsh working conditions? What do they do and how do they feel about their work and the conditions?

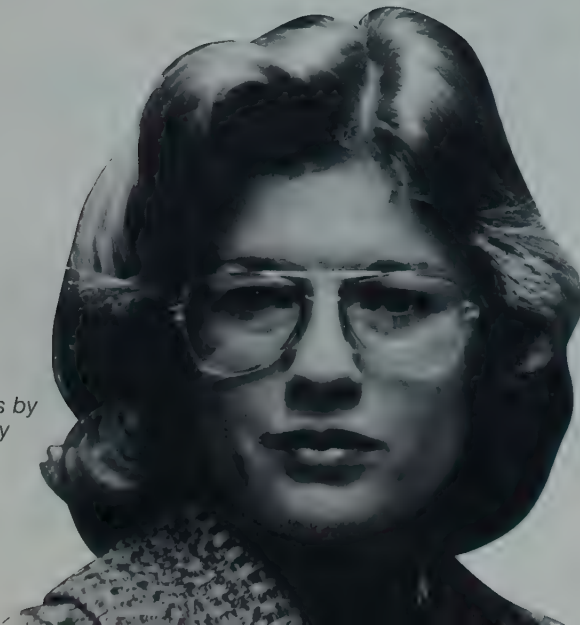
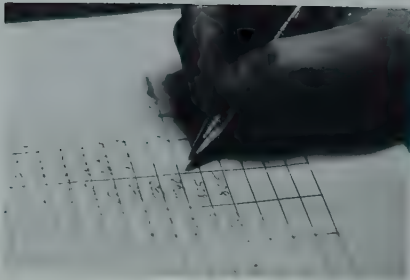
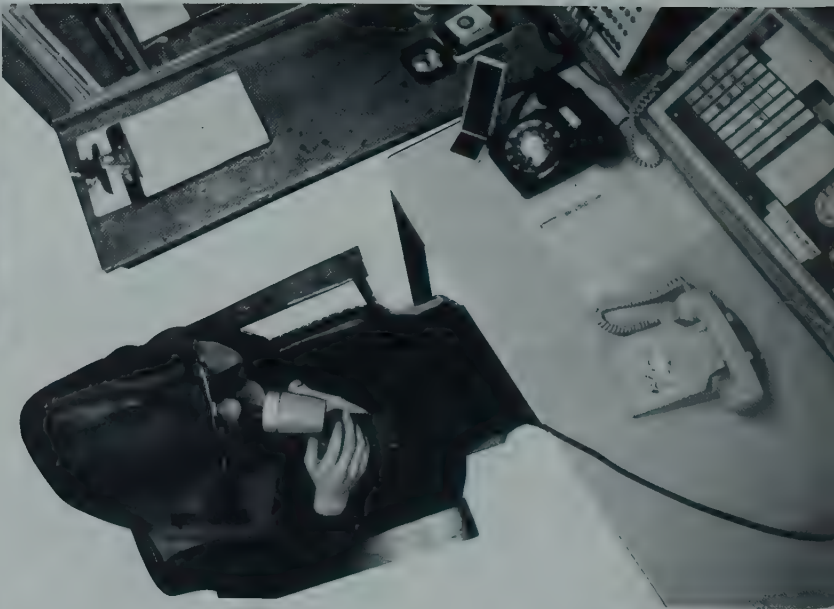
For weeks we flew to work areas ranging from Pump Station 1 in the north to the Terminal at Valdez in the south to find the women at work and talk to them. We slogged in the mud, slashed at mosquitoes and gnats. We braced against the wind and wrote with mittened hand in minus 10 degree weather. We even interviewed two of the women in front of a bus load of pipeliners waiting subsidence of the miserable drizzle, turning aside their quips and comments. And we asked the men how they felt about this unique situation — women working for the first time alongside men on a huge construction project.

First the men: Reactions varied from "I think it's neat" and "it's about time they got treated like individuals" to doubts that the women were really qualified for the jobs they held and "they should all go home and let the men have the jobs." One man,



Vicki Lane

Barbara Leahy is a relief communication center operator for camps along the trans Alaska pipeline. At Old Man Camp, north of the Yukon River, she handled four FM mobile radios; a citizen's band network; a telephone switchboard; a ringdown phone system; a public address system; a camp AM radio transmitter; a camp TV station and a fire alarm system.



Photographs by Bart Attebery

father of daughters in their twenties, said: "Two years ago I wouldn't have believed that this was any place for a woman. But I've changed my mind. Now two of my daughters are here and they're doing fine."

And the women: They are young to older — 19 years to more than 60. They are unmarried, divorced, widowed and married — some with husbands in camps, others on their own. They have all felt pressured to prove themselves in their work and most have been sexually propositioned overtly or by implication. They find the chaffing sometimes hurtful and hard to deal with and if they have families at home, they miss seeing them for the nine weeks or more they spend at a time on the line.

Yet these women are enthusiastic about their unusual contacts with people, revealing an awareness about both the people and their feelings which was surprising. They are highly complimentary about their crews or work gangs and have been grateful to champions who either stuck up for them or went out of the way to demonstrate a job technique. They make a point of being conscientious about their jobs and are critical of males who are not.

Although males have said that boredom was the biggest problem of

the camps, not one woman indicated that this was a concern. Some were occasionally wistful for "window shopping" or casual rides out in a city, but they dismissed this as a serious problem.

They feel they are well paid for what they do. And, they all admit that the chance at a substantial paycheck was a prime motivation in seeking the job. But there was also the sense of adventure, being part of an historic project and just a plain desire for "physical work."

The women want the money for different reasons and give feisty response to the men who say they should go home. Vee Ola Corso, 53-year-old widow who works outside flagging vehicles, says "I'm head of my household and I have the same right to send my daughter to school as you to send your kids."

Vicki Lane, 21-year-old rig oiler, has a two-year-old son to support and Atla Presley, 51, has a dependent mother and a mentally retarded son.

Clara King, bull cook, wants to finish her education after she earns enough to support their nine-year-old daughter.



Clara King

Vivian Eskew, a teamster and former cab driver, is looking at retirement for which she wants a mobile home and car — all paid for. Annie Diolier, laborer with a crew installing vertical supports for the

pipeline, wants to build a "cabin in the woods" and another laborer, Gaya Erlandson, college freshman with journalism interests, is just "getting together a grubstake."

But although money was the initial lure for most, the women have found other satisfactions, often surprising, in working on the pipeline.

Peg Arnold, mother of children ages 20, 25 and 33 says the nine weeks she spent as a bull cook at Franklin Bluffs were both an "adventure and learning experience."

"I learned to really accept how others live and think," she says. "Many things were really 'eye openers' to me, things that bothered me. But I learned to live with them because I personally could not change them. Most of the men talk of their families and I think part of the problem is that they are doing their work where the family cannot see, understand or appreciate their efforts. Young families often have not established the kind of communication, trust and understanding which can take separations."

Vee Ola Corso spends all her time out-of-doors and in spite of skin-roughing weather, and armies of mosquitoes, she loves it. In the long hours what does she think about? "I enjoy all that beauty," and she points to the fall tundra near Old Man Camp, ruddy with low plants and in the early morning light the brown is velvety like a sheared animal

pelt. "The birds, bears, wolves — all are my friends." Vee Ola worries, too, about the possibility of tourists "trashing up my road" if the haul road is open to public use. She keeps a constant eye on the traffic as the trucks and other vehicles thunder by, giving proper indications to those who come in or leave her access road. "I take good care of my trucks," she says, waving again at yet another friend of the road.

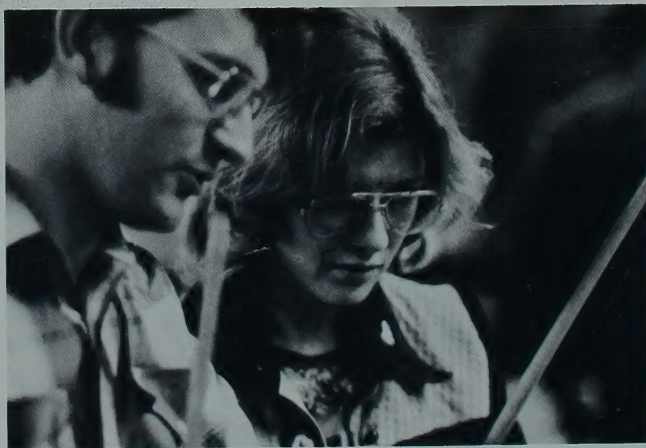
Vee Ola also says she never goes to the dining room without being properly dressed after her nightly bath, no matter how tired she is. And every Sunday she wears a dress.

"The men say they appreciate it," she says. "I think it depends on how a woman acts as to how she is treated. I don't mind their flirting — that's part of the game of camp life. But they treat me with respect. . . . I think this job is a privilege and an experience not many people have."

Ex-cabdriver Vivian Eskew says the crew for which she drives are "super-great" and she has a "fantastic boss." She, like the other women, is exceedingly interested in all aspects of the pipeline — the construction, terminology, equipment — "I can ask more questions in five



Vivian Eskew



minutes than they can answer in a week!" She fears that the kids getting the high rate of pay without having to pay out for board, room or transportation may have trouble back in the "ordinary" workaday world. And she knows she will have a problem getting the hang of meal planning and preparation again. "This freedom from home KP is the greatest."

Vicki Lane, a slight, blonde 21-year-old knows she has a "cushy" job as oiler but she says "I keep the cranes spotless." She says that she had a hard time at first and still winces at some of the guff and foul language which comes her way. "I'm not physically built," she says, "but I can drive a 10-speed. I can work the 10-inch crescent wrench and a large screw driver — and that makes an oiler." She feels that some men feel threatened by the presence of women on the line "but that's a problem within themselves."

A whole new world of career possibility has opened to Melva Miller, 22-year-old Athabaskan Indian now an apprentice ironworker at Pump Station 1. She began work there as a bull cook and a "couple of guys in the shop suggested I come down one night and they'd teach me to weld." Partly as a joke, Melva accepted — and found she liked it. She agrees that it was helpful to have the foreman friendly, but she also points out that she must pass the tests and must eventually do anything anyone else does in this line of work. "I don't want any favors." People have said that Melva lacks confidence, but in her quiet voice she says "I feel I have accomplished something." And although it has been "over a year since I put a dress on and I wear gloves all the time," she is seriously considering going on in the work as a career. One of the other ironworkers has encouraged her and said "I'd like to connect iron with you."

Bette Croghan says that in her job as security guard for the Alaska Native Corporation known as NANA (which has a contract with Alyeska for these services) she has "paid off two or three years of debts." Divorced, with two sons in high school, Bette took the job at first just to beat inflation and



Annie Diolier

prepare for her sons' college. But the other dividends have been equally as important to her. She walks more than 11 hours daily in

her rounds of checking safety of buildings, their furnaces and well-being of the occupants of the barracks. The first month she was "one mass of aches," but since then she's lost 20 pounds (the opposite of complaints of those for whom camp food is too tempting) and has "never felt better." She is grateful for the opportunity to know the Alaska Natives whom she finds "most genuine." She has no fears of people, animals or empty buildings, although the latter during the slow-down months depress her somewhat. She looks forward to the hour or so of outdoor rounds no matter what the weather. She thinks this getting out in the fresh air is important to mental attitudes as well as physical well-being. When she is out of earshot of people, she "chants, sings or meditates" on matters related to her metaphysical interests.

Winds may blow, cold may come, but Bette insists on keeping well-groomed. "I think it's important to maintain the image of our guards by neatness, promptness, business-like behavior," she says. Her uniform is the whipcord pants and coat known as the "Alaska Tuxedo." Under these she wears a white turtleneck topped by a grey shirt. Her down parka is sage green satin with a wolf ruff on the hood, and the shoulder patch bespeaks her organization. She is most adamant about how she behaves — doing a minimum of socializing so that she won't be compromised if ever she has to enforce a regulation involving someone she knows. Most of her work to date has been involved in oil burner inspections (fire can be disastrous in a remote camp), reminding workers to be quiet after ten at night and doing some shifts on gate duty where vehicles are checked in and out.

Bette also recognizes that life in camp is very protective in that it is structured and "can be an escape if you're looking for it." Bette, however, sees it as opportunity to relish and enhance her life.

When Barbara Leahy is the communications center operator, the men are cheered and pleased according to one of the supervisors. "She's accurate, has good diction and her voice always has a lift — an upbeat."

Barbara is communications center operator responsible for all communications both with camp mobile units and the outside world. This involves four FM mobile service channels (one for the execution contractor, one common, one emergency — fire truck and security — and one Alyeska camp net; citizen's band

radio; switchboard; ringdown phone system; camp public address system; AM music; TV translator (all videotapes); fire alarm system. She moves to various of the northern camps. Prospect Camp, she says, is a "truly beautiful camp. I'm now at my third week at Chandalar — this surely must be heaven. I could spend the rest of my life here and on Atigun Pass and never get bored."

She speaks of camp life thus: "I came to this life expecting it to be a positive experience and it is just that. It's something that I think probably no one who has not lived it can ever really understand. It's a very unreal existence, of course, and those of us who think about such things realize that if we are good at human and personal relations here, we can survive anywhere. The intensity of experiences (assuming one does not withdraw) stretches a person to the utmost."

Some of the women spoke of little chance to communicate with other women in any manner relating to more than small daily incidents. Barbara Maier, who spent the summer of 1975 at the Valdez Terminal camp as general laborer on a rock crusher, assesses her experience in terms of women generally in the context of the woman's movement.



Melva Miller

She expresses it thus: "My work week averaged 70 hours and as a rock crusher laborer I did a lot of shovel work and rock dodging. The crew consisted of one other woman and ten men. I went to work on the pipeline for a variety of reasons — to do physical work, to see what the pipeline was all about, to take advantage of a created opportunity for women and to earn good money. Maybe I also wanted a new adventure.

"For the first time I can say I know what it's like to be in a real minority. . . . Like a thousand times before, a woman goes to a new job and faces the male boss. The mad rush . . . the make is on because it seems it's always been that way . . . the pressure to do the job well, have a good relationship with fellow workers and be left alone. But here — no. The foreman pushes the issue and as a result a woman makes her statement. 'Yes, I'll opt for easier conditions in return for favors' or 'No, don't harass me.'

"There seemed to be little communication between women working in traditional female jobs and those doing physical labor. This is due to many things — lack of time — after shower and

dinner it's 9 p.m. — separateness of the crafts, exhaustion and since a female faces extra pressure during work hours and constant demands on her private time (because men think she has nothing better to do than listen to them) she reaches her room at night and doesn't want to talk to anybody. . . . Despite the fact that women have gained entrance to the pipeline scene, they must work harder at strengthening one another while there.

"The pipeline is a unique experience for women. It is an avenue in which the revolution can speak. It is causing drastic change in economic conditions. For once, pay scales are basically equal. The presence of women in construction has forced men to work alongside us, made for better working conditions and destroyed certain myths men held regarding the ability of women to do hard labor, etc.

"But, at the same time, the pipeline is only a gross exaggeration of all the discrimination women have faced for centuries. . . . There is constant harassment, sexual slurs, placing women in areas of little or no responsibility, etc. . . . I feel that any healthy woman wanting to work on the pipeline can do the physical work. I believe in most cases, a woman who makes it clear that she wants to work will be treated fairly. And the flip side of the coin — if she wants the easier street, that avenue is always open.

"We need (in Anchorage) to really acquaint women with unions, construction terminology, the pipeline experiences, etc. The pipeline has made it possible for women to gain some measure of economic freedom . . . the confidence women have gained from working on the pipeline must be shared. The road for women and construction is just beginning."

Progress Report

Although pipeline construction during January and February was held back, as expected, by the winter weather, work on the Valdez terminal and pump stations continued.

Project manpower levels declined to approximately 7,000 persons in late December, but are now swiftly approaching a projected summer peak of 21,000 workers.

Construction activities on the pipeline itself were confined to critical stream crossings and the installation of vertical support members. These projects were shown to be cost effective despite the cold. Also continuing over the winter months were equipment maintenance, inventories, material coordination, intensive planning and scheduling efforts in preparation for the 1976 summer construction season in which the pipeline portion of the project is scheduled for completion.

During the winter, stream crossing construction was centered on those areas where work needed to be completed while streams were frozen to avoid later environmental disturbances. All foundation work was completed in March on the 1,200-foot suspension bridge across the Tanana River south of Fairbanks. Tower superstructures were assembled on the ground at the same time. Completion of the bridge, second largest in Alaska, is scheduled for August.

In-stream work on a major crossing of the Sagavanirktok River, north of the Brooks Range, was also carried out as was construction of the substructure and temporary supports for an aerial pipeline crossing of the Gulkana River, north of Valdez.

Work on a crossing of the Tazlina River will begin this month.

Of more than 78,000 vertical support members required for approximately 425 miles of above-ground mainline pipe, nearly 60,000 have been installed. The pipeline work pad is nearly finished. Completion is scheduled this spring with the exception of one short section on the south end of the line, which will be completed in late summer.

After a short mid-December shutdown, snow-pad construction began in January for the gas fuel line between Prudhoe Bay and Pump Station 4, north of the Brooks Range. Ditching and welding on this 145-mile line resumed in early February, and, by March, work was advancing steadily toward a mid-May completion date.

Work crews in Section 1, near Valdez were being mobilized to begin work on the line over Thompson Pass. Construction of this challenging part of the line and in Keystone Canyon, south of the Pass, will be started as soon as the ten-foot snows leave the area. Because of tremendous snows that come early and leave late, there is only a short period available to complete the work on these sections.

At the Valdez Terminal four buildings in the ballast water treatment facility were enclosed, enabling inside work to continue throughout winter. All underground pipework and concrete pouring was completed in the air-flotation treatment building of that facility. Thirty of 34 pumps to be installed in the building were put in place.

Major work in the power generation and vapor recovery

complex consisted of pouring concrete for pipe supports, equipment foundations and the switching building foundation. All three required steam turbines and boilers were installed in the power plant.

At the East Tank Farm, work included pouring concrete for the containment walls between the tanks, and installing oil and sewer lines. Excavation continued at the West Tank Farm on rough grades for four tanks. Foundations were poured for three tanks. Eighteen tanks will be needed for pipeline operation at the 1.2 million barrel daily operations level.

Work also continued on the main incoming crude-pipe tunnel which passes under a road leading into the Terminal complex. Excavation was also completed for an oil-line bridge over a creek and for various pipe supports.

Heating and ventilation-duct work on the terminal control building continued through the winter. This building will contain the operation Control Center. From this facility, a microwave system will provide voice contact among pump stations and carry commands to the stations. This backbone communications system is nearing completion. Work is also underway to link each of the 62 remote valves into the communication network. Operated by radio from the Control Center, this valve system will be used to stop oil flow in the event of a malfunction or damage to the line. A satellite for backup communications was launched into orbit in December.

Piping and conduit along the roadway to Tanker Berth 4 have been installed. Preliminary work has begun on pre-drilling operations at Berths 1, 3 and 5.

Work continued at pump stations throughout the cold winter months, with a stable manpower force of approximately 1,800 persons.

A major milestone in that portion of the project was the enclosure of nearly all pump station buildings, allowing the pace of interior work to accelerate. Emphasis during the winter was on electrical, piping and ventilation duct work.

With the completion of initial mainline pump and turbine installations last year at Pump Stations 1, 3, 4, 8 and 10, delivery and installation of additional pumps, turbines and other permanent facilities have begun.

Hydrostatic testing of tanks is scheduled to begin this spring. By early this month, the first power-unit modules for remote gate valves will be set.

Tents shelter workmen during winter construction effort

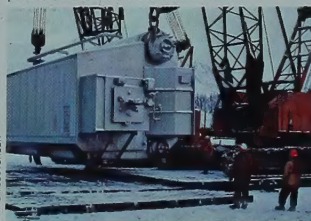


Support awaits cable at Tanana River Crossing



Workmen lower pump assembly at Pump Station 10

Boiler assembly in position at Valdez Terminal



Rock drill moves to work site on North Slope

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Alyeska Pipeline Service Company
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Anchorage, AK 99504

E. L. Patton, *President*

Alyeska Pipeline Service Company has committed itself to keeping the public informed about its progress in the design, construction and, eventually, operation, of the trans Alaska pipeline.

To help meet this commitment, Alyeska has undertaken the quarterly publication of this magazine, *Alyeska Reports*. Your comments and suggestions are welcome.

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Alyeska pipeline
SERVICE COMPANY

Alyeska pipeline safety program cuts accident level to a point far below predictions

In the early spring of 1974, as the first work crews for the trans Alaska pipeline project began to mobilize, predictions by trade and governmental spokesmen were that death and injury rates for the project would reach heights unprecedented in modern construction.

One government prediction was 1.18 deaths for each million hours worked. Some labor officials called that estimate "too conservative". And there was considerable speculation that the harsh Arctic working conditions would lead to a large number of cold-related injuries and illnesses.

But, after two full seasons of construction along the 800 mile pipeline route; after the expenditure of more than 75 million working hours, fatality rates are less than one-quarter of the early prediction. Heart-related cases are 75 percent below national norms and fewer than 1 percent of the total injuries have been cold-related.

Contract construction industry figures for 1974 showed a national rate of 18.3 injuries requiring medical treatment for each 200,000 hours spent on the job. The trans Alaska pipeline project figure stands at 13.2 — nearly 28 percent below the national figure. Most pre-construction injury predictions projected the rates to be substantially above national levels.

The low accident figures are the direct result of a carefully engineered safety program, built around a core of fewer than 50 highly qualified safety specialists employed by Alyeska Pipeline Service Company and its major contractors.

All members of the safety corps are experts — men with many years of practical experience in construction and petroleum safety and in fire protection and industrial hygiene.

The project loss prevention philosophy is best described as one of "controlling risk." Hazards once identified are either eliminated, modified or assumed — a management decision based on probability and consequence of occurrence.

The safety engineers are members of the respective construction management staffs, and their work is done with an eye to work progress through identification of work hazards and analysis of the risks involved. An effective system of communication between all levels of supervision assures that personnel on the job are aware of hazards and of the best methods of controlling them.

Operating on the principle that work stoppage, or avoidable expense, arising from an accident is failure on its part, the safety team has effectively identified and recommended controls for hazards, thus contributing to rapid construction progress and a desirably low accident rate.

An Alyeska contractor uses a gigantic rock chain saw to slice a neat and narrow ditch in the frozen North Slope for a small pipeline being built to carry natural gas to fuel pump stations along this northern section of the line.

Sub-zero temperatures at Galbraith Camp in the Arctic chill more than just the men and women working on the trans Alaska pipeline. Alyeska has had to strengthen many machines to withstand the rigors of the cold and develop new techniques to keep them running.

Being a woman on the trans Alaska pipeline is no picnic, some women report. Yet about 1,900 of them, some at Old Man Camp, took part in construction last year with 55 percent in such non-traditional jobs as laborers, ironworkers, teamsters, operating engineers and surveyors.

Construction workers at the Valdez Terminal moved inside to continue work on many of the facilities there during the winter. After enclosing terminal buildings, crews started installation of machinery and equipment inside to maintain work progress throughout the winter.

Many of Alaska's most spectacular geological features may have been formed — and may still be in the process of being formed — as three great tectonic plates of continental rock come together in the Alaska area.

